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The Potential of Living Plants Harnessing Bio-Electricity through Bio-Photovoltaic Device

Atit Kumar Jawre[1] and Prof. Sardul Singh Sandhu[2]

[1]Department of Biological Science, R.D. University, Jabalpur 482001, Madhya Pradesh, India

[2]Bio-Design Innovation Centre, R.D. University, Jabalpur 482001, Madhya Pradesh, India

E-Mail id: atitbiordvv@gmail.com

ABSTRACT

The electricity crisis is determining the most pressing issues in the world that is escalating synchronously. Currently, a variety of sources are used to generates energy, but the by-products are extremely detrimental to peoples and the environment. In the present study, we developed and fabricated a low-cost and eco-friendly technology i.e. bio-photovoltaic device (BPVs) that uses an organic framework to produce green energy. Indeed, the BPVs device utilises the specific characteristics of the plant-microbes relationship in the rhizosphere region of the plant to modify solar energy into electrical energy through the bio-electrochemical method. The BPVs device was formulated in a grass *e*-table under the observed natural condition for the power yield of 0.57 ± 0.2V to 4.23 ± 0.2V at 30 days of the incubation period. The current study was pointed on harnessing bio-electricity using the biosystem which also addresses the existing electricity crisis. However, this technology is still undergoing many pieces of research work but has a good potential change worldwide and providing sustainable energy without harming the plants and environment.

Key-words: Bio-Photovoltaic device, Grass *e*-table, *Cynodon dactylon*, Bio-Electricity generation.

INTRODUCTION

In recent decades, the feasting of oil and gas has increased due to population growth, industrialization, and urbanization, leading to an energy calamity and environmental effluence [1]. Therefore, these are basic needs is fulfilled by paying high capital prices (Approx. 30 billion per year) an example for the economic survey of India. Biomass has attracted a lot of interest as

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a potential source of energy due to its abundance and flammability. However, an estimate of over 67% of electricity is formed of fossil fuels

than most of the researchers undergoing on harnessing electricity from renewable and sustainable sources like solar, wind, water, nuclear and biomass. In present time the world-wide electrical energy is obtained from nuclear reactors (13.4%), hydropower and wind (16.2%), solar and biomass (3.3%). However, there are some disadvantages to renewable energy sources [2]. These are the main source of electricity production by fossil fuels. The Bio-Photovoltaic device produces green electricity by using plants and mutual interaction of microbes that oxidized the organic residues harvest an electron. These electrons trapped by the conductive electrodes situated bio-system as well as the assimilation of the anode and cathode nearby the plants-roots and soil-surface causes the electrons to be fascinated towards the anode due to its negative charge and proton is involved towards cathode due to its positive charge thus generates green electricity through the bio-electrochemical system as depicted in Figure 1 [3]. This means that they alter chemical energy into electrical energy using biological material during photosynthesis. This is founded on the natural process without harming living plants and the environment. This innovation is a supportable and renewable process without zero discharge and obstruction for farmable land and nature. This is a good scope for the usage of BPVs is perfect in wetlands as a massive waterlogged spot is required [4].

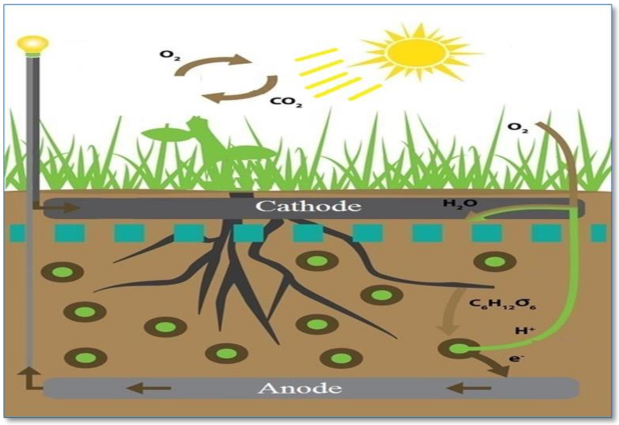

Fig. 1. Showing of Bio-Photovoltaic device (Bombelli *et al*., 2016) [3]

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MATERIALS AND METHODS

Collection of Plant Material

During the experimental work, the grass species of *Cynodon dactylon* was collected from the departmental garden, Rani-Durgavati University, Jabalpur (M.P.). The development of bio-photovoltaic device (BPVs) for the initial green electricity generation. The *Cynodon dactylon* is a plant genus classified under the Poaceae family which is usually grown in the soil salinity place that is recognized of Indian name called as Dooba Grass.

Experimental Setup of Bio-Photovoltaic Device

In this work, the bio-photovoltaic device was the fabrication of cathode and anode site and assembly was performed in an indoor laboratory condition. At BPVs was built by using cylindrical plastic pot which is commonly used in India for household plant growth. The BPVs setups consist of plastic container, with the dimensions of 8.5cm x 9cm x 8.5cm (length x width x height). The cathodic compartment comprises of copper electrode but proton exchange membrane (PEM) that was not used in the cathode chamber. Copper electrodes placed on the top of the soil surface. While other zinc electrode inserted near the plant-roots of *Cynodon dactylon*. Assembling the BPVs device, an electrical network to make a complete circuit using alligator clips and electrons move through in the complete circuits. The entire work was executed without connecting any resistance load. After 5-7 days of the proper maintains of growth and development of living plants, set of water was added and electricity potentials in BPVs device were recorded according to the method described by Smil *et al*., (2010) [5].

Influence of Light and Dark Condition

The power output was measured in voltage on an hourly basis from 10 AM to 5:30 PM at 10 days during light and shade condition. The average voltage obtained for each of the BPVs cells was intended and designed for BPVs performance. Similarly, in the same process for the output voltage was checked during the dark condition and measured for each of BPVs device for 10 days respectively the readings were recorded with the help of digital multimeter [6,7]

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To Formulation of Grass *e*-table for Bio-Electricity Generation by BPVs device

After the optimization of various condition for the maximum generation of green electricity than the formulation of grass *e*-table constructed was done. The couples of conductive electrodes were used as copper and zinc and the zinc placed in contact with the plant roots. While a set of copper electrode was submersed in the soil-surface. The copper cable was used to connect with both electrodes as the current collector. The performance of the Grass *e*-table device can efficiently be improved by connecting 12 BPVs devices and enhanced the power density, connected in the series arrangement of BPVs device and measurement of electricity with digital multimeter [8].

RESULTS AND DISCUSSION

The significant results found from the present examination are compiled under this work along with the results and discussions for the Bio-Photovoltaic device (BPVs) of potentials differences with light and dark conditions.

Influence of Light and Dark Condition

To scrutinize the effect of sunlight on the electric output, the BPVs pots were kept in light (L1) conditions in the replicates of three for 10 days. Annotations were recorded for both the conditions with the help of multimeter and that was found for the samples with and without plant. For L1 under light condition, the maximum generated potential of 0.60 ± 0.02V with plant and 0.33 ± 0.02 V without plant (control) was observed on to 10 days respectively. The set up of S1 were placed under shade condition measurement of voltage for BPVs pots. For S1 under shade condition, the maximum generated potential of 0.50 ± 0.02V with plant and 0.33 ± 0.02 V without plant (control) was observed on to 10 days respectively as presented in figure 2. Chlorophyll is necessary for the principle of photosynthesis and the release of electrons used in the production of electricity. Similarly, the green electricity production from *Epipremnum aureum* for the maximum voltage output 195mV was achieved 10 days of incubation period in P-

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MFCs setup. Furthermore, Pamintuan *et al*. (2020) harvested bioelectricity form three house plants like spider plant

(*Chlorophytum comosum*), Portulaca flower (*Portulaca oleracea*) and Dumb canes (*Dieffenbachia amoena*). In that setup of P-MFCs was obtained of 0.58 V attained per plant [8].

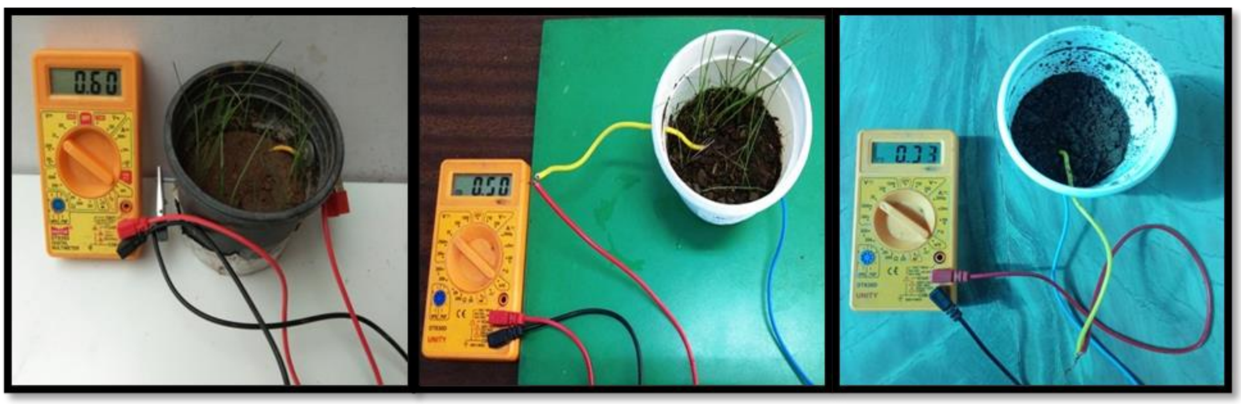

Fig. 2. BPVs pots generate in voltage with light (L1), shade (S1) and control Condition.

To Formulation of Grass *e*-table for Bio-Electricity Generation by BPVs device

This BPVs system-generated initially reading was low then after 7 days of incubation, then steadily raise the voltage. It showed the increasing trend up to 30 days and an identical well-maintained result with values was recorded 0.57 to 4.24 ± 2V for consecutive to study the effect of light on voltage and it was detected that voltage increased proportionally to the duration of sunlight. Finally, attained to evaluate of the effect of the grass *e*-table designed upon the generation of voltage using *Cynodon dactylon* in BPVs device was utilized as an energy source. It was found that electricity generates a maximum voltage of 4.24 ± 0.2 V on the 30 days of incubation as shown in figures 3 and 4.

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Fig. 3. Showing of bio-electricity generation in Grass *e-table*

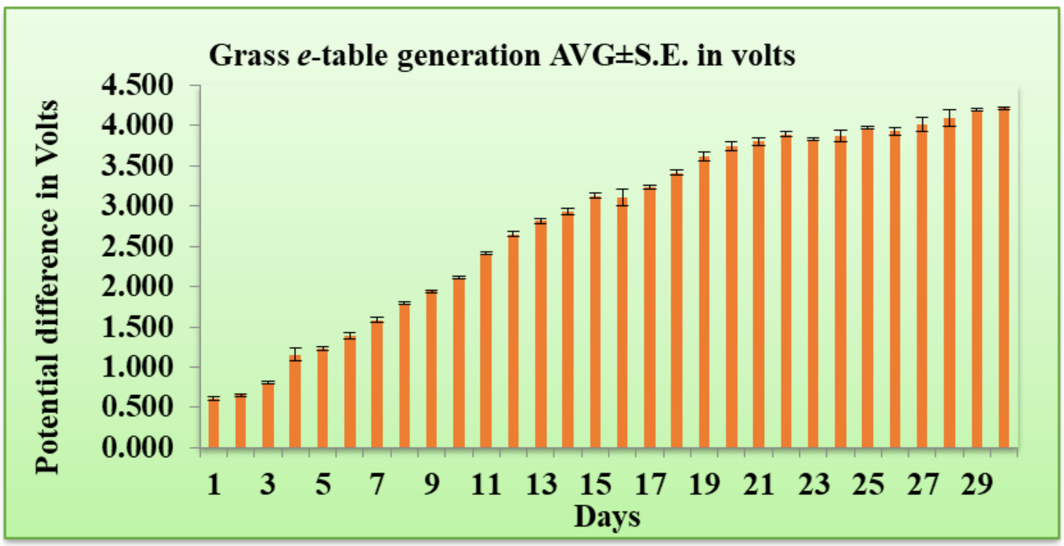

Fig. 4. Electricity generates in volts from grass e-table with standard errors bars

CONCLUSION

The current work has been shown the proof of principle constructed the biophotovoltaic device technology and signifies an innovative approach for using plant rhizodeposits that help as a substratum to bacteria for produce green electricity. The main emphasis of this study was on bio-electricity generation with the help of *Cynodon dactylon* by using bio-photovoltaic device.

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Further, formulate in grass *e*-table for enhanced production of green electricity it can be used at different places of the city where electricity consumption is high like in shopping malls, government office and corporate etc., in such designed ways that bring the city look like smart-city. This technology is eco-friendly and providing sustainable energy. This non-destructive method is cost-efficient and can be set up in rural as well as in urban areas (green roofs) to meet the rising demand for electricity and increase in the area as well as the number of grasses that would be put to use for the production of bioelectricity. The study also suggests fine-tuning technology to make better use of wastes for commercial purposes, such as the generation of alternative energy, to fulfil the demand in the world.

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CONFLICTS OF INTERESTS

There is no closing conflict of interest concerning the current research. Authors have to examine and announce the manuscript and agreed to submit it for publication.

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